GEOPHAGUS ARGYROSTICTUS, A NEW SPECIES OF CICHLID FISH FROM THE RIO XINGU, BRAZIL

by

Sven O. KULLANDER (1)

ABSTRACT. - *Geophagus argyrostictus* sp. n., reaches 162 mm SL and is distinguished from other *Geophagus* species by having silvery reflecting spots on the side and a dark vertical stripe below the eye. It is the first substrate brooding species to be recorded in the genus. Collecting localities are in the upper (Cachoeira von Martius) and lower (Belo Monte, Altamira, Cachoeira do Espelho, Rio Curuá) Rio Xingu drainage. Samples from the two geographical areas differ slightly in colour, morphometry and meristics.

RÉSUMÉ. - *Geophagus argyrostictus* sp. n. atteint 162 mm LS et se différencie des autres espèces du genre *Geophagus* par des points argentés sur le flanc et une bande sombre au-dessous de l'oeil. C'est la première espèce du genre à être signalée comme pondant sur substrat. Les collections proviennent du cours supérieur (Cachoeira von Martius) et inférieur (Belo Monte, Altamira, Cachoeira do Espelho, Rio Curuá) du Rio Xingu. Les deux échantillons géographiques sont différenciés par des caractères morphométriques, méristiques et chromatiques.

Key-words. - Cichlidae, *Geophagus argyrostictus*, Brazil, Amazon River, Brooding behaviour, New species, Taxonomy.

The South American cichlid genus *Geophagus* Heckel includes eight nominal species of which recent papers described or redescribed *G. proximus* (Castelnau), *G. surinamensis* (Bloch), *G. brachybranchus* Kullander & Nijssen, *G. brokopondo* Kullander & Nijssen and *G. harreri* Gosse (Kullander, 1986; Kullander and Nijssen, 1989).

This paper describes one more species that was first separated from material identified by Gosse (1976) as *G. surinamensis*. A photo of one of the paratypes meanwhile appeared in Stawikowski and Werner (1988) and the species has since also been introduced in the aquarium hobby (Stawikowski, 1989, 1990a, b).

METHODS AND ABBREVIATIONS

Procedures for taking measurements and counts are as described by Kullander (1979, 1980, 1990) and Kullander and Nijssen (1989). The preserved material is housed in the following institutions: IRSNB = Institut royal des Sciences naturelles de Belgique, Brussel; MZUSP = Museu de Zoologia da Universidade de São Paulo; NMW = Naturhistorisches Museum, Vienna; NRM = Swedish Museum of Natural History, Stockholm; ZSM = Zoologische Staatssammlung, Munich.

---

(1) Department of Vertebrate Zoology, Swedish Museum of Natural History, POB 50007, S-104 05 Stockholm, SWEDEN.

Cybium 1991, 15(2): 129-138.

GEOPHAGUS ARGYROSTICTUS SP. N.

(Figs 1-4, Tables I-II)

Geophagus surinamensis (*pt.*, *nec Sparus surinamensis* Bloch) Gosse, 1976, p. 25 (IRSNB 17403 [now IRSNB 785, part of type series of *G. argyrostictus*]).

Geophagus Stawikowski & Werner, 1988, p. 167 (monochrome photo [IRSNB 785, 73.2 mm SL]).

Geophagus sp. "Tränenstrich-Erdfresser" Stawikowski, 1989, p. 479 (habitat), fig. 10 (colour photo).

Geophagus spec. "Tränenstrich-Erdfresser" Stawikowski, 1990a, p. 8 (note), fig. 2 (colour photo). -- Stawikowski, 1990b, p. 519 (breeding behaviour), fig. (colour photo).

Diagnosis

Distinguished from most other *Geophagus* species by having a dark vertical stripe below the eye in specimens of all sizes, and uniquely distinguished from other *Geophagus* species by silvery reflecting scales on the anterior sides and/or over the midlateral spot in specimens from ca 70-80 mm SL.

Material examined

Holotype: MZUSP 32906 (Fig. 1). Adult female, 98.1 mm SL. Brazil, State of Pará, Rio Xingu drainage, Belo Monte, rocky pool near cachoeira. 26 Sep 1983. Collected by M. Goulding.

Paratypes: Brazil, Rio Xingu drainage: MZUSP 39087 (17 spms) and NRM 13981 (5 spms). 22 spms, 39.0-75.0 mm. Same data as holotype. - MZUSP 36875. 4 spms, 91.1- ca. 180 mm. Est Pará, Cachoeira do Espelho. 23-26 Oct 1986. P.E. Vanzolini. - NRM 13997 (5 spms) and ZSM 27494 (3 spms). 8 spms, 71.3-126.7 mm. Est Pará, Rio Xingu, Balneario Pedral ca. 8 km S of Altamira. 24 Sep 1988. R. Stawikowski, B. Kilian, U. Schliewen. - NMW 24023. 1 spm, 161.8 mm. Est Pará, Rio Iriri-Curuá [mouth of Rio Curuá]. 7 Aug 1909. E. Snethlage. - IRSNB 785. 44 spms, 53.1-129.6 mm. Est Mato Grosso, Cachoeira von Martius. 29 Oct 1964. J.-P. Gosse and Léopold III (Sta. 114).

Description

Based on material from Belo Monte, Altamira and von Martius, ca. 100 mm and larger, unless stated otherwise; counts from 27 measured specimens or 76 specimens; measurements are summarized in table I. Refer to Figs 1-2 for general aspect.

Table I. - Morphometry of *Geophagus argyrostictus* from the lower (N = 12, 68.6-161.8 mm SL, MZUSP 32906 (1), MZUSP 39087 (2), NMW 24023 (1), NRM 13997 (5), NRM 13981 (3)) and upper (N = 15, 63.9-117.5 mm SL, IRSNB 785) Rio Xingu. Measurements are in per cent of SL; measurements of holotype (HT), 98.1 mm SL, both included in lower Xingu sample and given separately.

	Lower Xingu				Upper Xingu		
Measurement	*N*	*Min-Max*	*X̄±SE*	*HT*	*N*	*Min-Max*	*X̄±SE*
Head length	12	30.0-33.3	31.7±0.29	32.0	15	29.9-33.7	32.1±0.26
Snout length	12	10.5-14.7	12.5±0.41	12.1	15	11.3-13.9	12.8±0.21
Body depth	12	35.8-44.1	39.7±0.60	40.8	15	34.6-39.8	37.1±0.34
Orbital diameter	12	9.0-11.2	10.1±0.15	11.2	15	9.6-11.0	10.4±0.11
Head width	12	11.9-14.5	13.6±0.19	14.5	15	13.5-14.5	13.9±0.08
Interorbital width	12	6.9-8.9	7.7±0.14	8.0	15	6.7-7.8	7.0±0.08
Preorbital depth	12	10.0-13.6	11.5±0.38	12.1	15	9.2-12.1	10.9±0.21
Caudal peduncle depth	12	12.8-13.9	13.4±0.10	13.6	15	12.4-14.2	12.9±0.14
Caudal peduncle length	12	15.9-19.3	18.1±0.27	18.2	15	16.6-19.4	17.9±0.22
Pectoral fin length	12	30.3-36.1	32.7±0.48	36.1	15	27.7-31.4	30.1±0.29
Pelvic fin length	12	28.1-53.2	39.8±2.41	48.2	15	25.5-41.5	31.9±1.33
Last D spine length	12	16.7-22.0	19.5±0.51	21.0	14	16.6-21.3	18.6±0.36

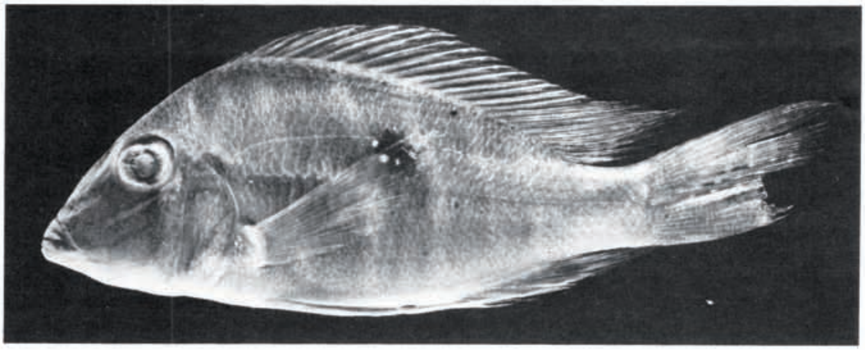

Fig. 1. - *Geophagus argyrostictus*, holotype, MZUSP 32906, 98.1 mm, from Belo Monte, lower Rio Xingu.

Elongate or moderately elongate. Cachoeira von Martius material more slender than lower Xingu material (cf. Figs 1, 2). Strongly compressed laterally, especially back and nape; chest flattened. In anterior view narrowly oval or rather triangular in outline, dorsally pointed, ventrally flattened. Dorsal contour sloping from dorsal fin origin; ventral contour slightly arched, often nearly horizontal, deepest at origin of pelvic fins. Ventral margin of caudal peduncle much longer than dorsal margin.

Head compressed, deep. Predorsal outline straight or slightly curved; in some specimens with slight indentation anterior to orbit. Ventral head contour about straight, feebly rising from ventral trunk contour. Orbit well below predorsal contour, major portion in posterior half of head length, entirely in upper half of head. Interorbital area slightly convex. Snout rounded, slightly attenuated especially in Altamira and von Martius samples. Mouth little wider than interorbital area. Jaws isognathous. Maxillary tip only slightly exposed, the vertical axis through its posterior end reaching to about halfway between nostril and anterior margin of orbit. Ascending premaxillary processes not quite reaching the orbit. Nostril about halfway between orbit and snout tip. Opercle about twice as deep as long. Preopercular margin without serrations. Lips thick; upper lip fold medially interrupted, dorsally covered by prominent postlabial skin cover. Everted lower lip fold wide, interrupted near symphysis.

Flank scales ctenoid. Scales in E1 row 32(7), 33(45), 34(16). Predorsal scales smaller than flank scales (anterior about half size of flank scales), a clear transitional region above about 3rd to 4th upper lateral line scales; mostly ctenoid, some small scales cycloid. Chest and abdominal scales ctenoid, about half as large as anterior flank scales. Prepelvic scales cycloid except between pelvic fin bases, numerous, small, about one-fourth size of anterior flank scales. Region opposite tip of cleithrum without scales. Cheek posteriorly with 6-7, exceptionally 8-9 rows of round thin scales. Anterior half and, narrowly, ventral margin of cheek naked. Cheek scales cycloid except in dorsocaudal corner, gradually smaller from dorsal and caudal (about half flank scale) to ventral and rostral (to about one-fourth size of anterior flank scales). Opercular scales small, cycloid along anterior margin, ctenoid on dorsal half; their size varying but smaller than anterior flank scales. Usually the major part of opercle naked, with or without scale pockets remaining. This scaleless condition is probably due to a loss of the delicate scales. Subopercular scales in two (occasionally three) parallel series, ctenoid and cycloid;

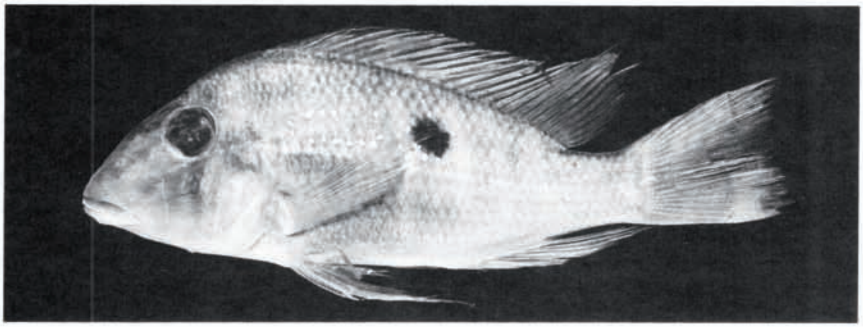

Fig. 2. - *Geophagus argyrostictus*, paratype, IRSNB 785, 109.8 mm, from Cachoeira von Martius, upper Rio Xingu.

the largest scales about half size of anterior flank scales. One or two small embedded cycloid scales on interopercle next to subopercle, sometimes wanting. Preopercle naked. Circumpeduncular scales 8-9 above and 10-11 below lateral lines. Scales between vent and anal fin 3-4.

Upper lateral line in E3 scale row, anteriorly rising for about five scales, caudad slowly descending; overlapping lower by 4-6 scales; separated from scaled basal sheath of dorsal fin by 7-8 (anteriorly), 4-4½ (at middle), and 3-3½ (terminally) scales. Lateral lines with tubed scales only: 21/13 (3), 21/14 (8), 21/15 (3), 21/16 (1), 22/13 (1), 22/14 (4), 22/15 (6), 23/14 (1), 23/15 (1); two scales continuing lower line on caudal fin, which also has long additional rows of tube bearing scales between rays D3 and D4, and V4 and V5.

Pelvic and pectoral fins naked. Spinous anal fin with narrow sheath of cycloid scales basally in specimens over 120 mm SL. Base of dorsal fin covered by narrow sheath of cycloid and ctenoid small scales throughout its length except for 6-7 posterior interradial membranes. Interradial dorsal fin scales appear in specimens between ca. 80 and 90 mm SL - specimens over 90 mm all with interradial scales - on each interspinous membrane from behind 5th-11th spine, but not beyond anterior 6 soft part membranes. Interradial scales in single series of up to 10 minute, cycloid scales, embedded in skin. Depth of basal and interradial scale zone less than 1/4 length of last spine.

Caudal fin extensively scaled dorsally and ventrally, almost to hind margin of fin, but only to about 1/4 of fin length over middle portion. Ventral lobe squamation much denser than that of dorsal lobe, forming a sheath. Scales ctenoid and, except next to base, small.

Origin of dorsal fin slightly before vertical axis from hind edge of opercle. First spine not quite 1/3 length of last, spines increasing to fifth, sixth or seventh, from which equal; last again slightly longer. In small specimens short, free lappet tips; large specimens with pointed or rounded lappets with long free posterior edge, reaching well beyond spine tips. Soft dorsal fin in small specimens rounded, reaching to slightly beyond caudal fin base; in large specimens pointed, but never filamentously produced, reaching to 1/3 to middle of caudal fin. D. XVI.12 (3), XVI.13 (1), XVII.11 (21), XVII.12 (43), XVIII.10 (1), XVIII.11 (5), XVIII.12 (2). First anal spine opposite penultimate dorsal fin spine; soft portion of anal fin pointed, 3rd ray longest, reaching to 1/4-1/3 of caudal fin. Small specimens with rounded soft portion of anal fin, reaching to about base of caudal fin. A. III.7 (8), III.8 (67), III.9 (1). Caudal fin slightly concave or truncate, with pointed corners; ray D7 slightly produced; 16 principal caudal rays; 6-7 dorsal, 6-7 ventral procurrent rays. Pectoral fin asymmetric, subacuminate, with rounded tip; 4th ray longest, extending to above first to third anal fin spine. P. 14(2), 15(20), 16(25). Pelvic fin inserted below and slightly behind pectoral axilla; pointed, first ray longest, with delicate filament reaching to near end of anal fin base or middle of caudal peduncle in large specimens. In small specimens first pelvic ray not produced, reaching to anal fin origin.

Teeth conical. In specimens up to ca. 90 mm SL all teeth about uniform in size. From this size teeth in labial row stronger than inner teeth and with blunt tips. Inner teeth in 2-3 rows anteriorly, slender, pointed. In upper jaw about one-third of each jaw half posteriorly edentulous; in lower jaw only anterior half of each jaw half dentigerous. In upper jaw outer row teeth well spaced, with slight size increase forwards. Inner teeth in upper jaw in a caudad narrower band; symphyseal area edentulous. In lower jaw outer row teeth well-spaced, size uniform. Inner teeth in lower jaw concentrated in bilateral narrow patches anteriorly; symphyseal region broadly toothless. Teeth number in outer row in both jaws negatively correlated with SL. Belo Monte and Altamira specimens averaging more teeth than von Martius specimens (19-30/19-26 vs 9-24/12-24 in range 69-98 mm SL); upper jaw outer hemiseries with 9-30 in 26 specimens 63.9-161.8 mm, lower jaw outer hemiseries with 12-26 in 25 specimens 63.9-161.8 mm.

First gill arch externally with 9-10 epibranchial, 1 in angle and 9(1), 10(6), 11 (39), 12(21), 13(9) ceratobranchial gill rakers. Gill filaments moderately long.

Microbranchiospines observed in only two specimens: one (73.1 mm) having a few dorsally on external face of 2nd and 3rd gill arches; the other (94.6 mm) having a complete row externally on the fourth arch.

In two specimens examined, 4-5 small close set tooth plates on ceratobranchial 4, each with 4 to 7 conical or unequally bicuspid slender teeth. Lower pharyngeal tooth plate (Fig. 3) with anteriormost two pharyngeal teeth simple, remainder with posterior antrorse point and one or two rostral edge cusps or bulges. Mediocaudally on the plate the teeth are submolariform, apparently worn.

Vertebrae 14+17=31(1), 14+18=32(5), 14+19=33(1), 15+18=33(5). Caudal ribs 8-10.

Coloration

Preserved colour pattern: ground colour pale yellowish white. Chest and prepelvic region silvery; abdominal edge whitish; ventrally on caudal peduncle and narrowly along anal fin base whitish.

Snout, lachrymal and upper lip pale or neutral grey. Lower lip, isthmus, branchiostegal membrane, lower jaw, inter- and pre-opercles whitish or very faintly greyish. Opercle and subopercle whitish, except superiormost portion of opercle (behind eye) which of duskier head colour. Cheek yellowish, turning to greyish anteriorly. Eye blackish dorsally, turning to silvery ventrally. Usually a blackish extension of the suborbital stripe ventrally on iris.

In specimens about 70-80 mm SL and larger, up to 28 small silvery reflecting dots irregularly scattered over the scales of the anterior flanks, especially close to the lateral line, not posterior to the midlateral spot; very faint or absent in Belo Monte and Altamira specimens in which instead silvery reflecting dots on and bordering the midlateral spot are particularly prominent.

Dark vertical bars on the sides indistinct, slightly backwards inclined, with narrow, slightly paler interspaces. Only the interspaces bordering the bar containing the midlateral spot contrasted, if any vertical barring at all obvious. The posteriormost bar descends from the posterior half of the dorsal margin of the caudal peduncle; the second is below the end of the soft dorsal fin; the third to

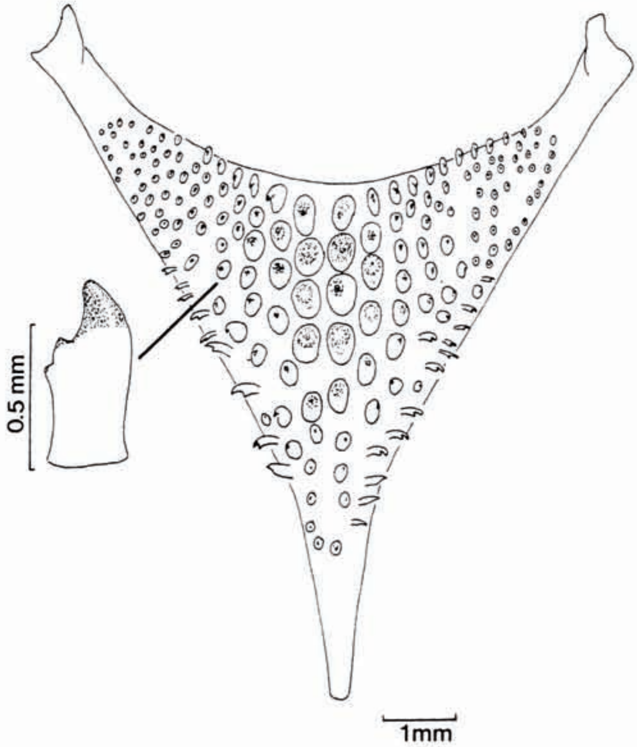

Fig. 3. - *Geophagus argyrostictus*, occlusal aspect of lower pharyngeal tooth plate and medial aspect of tooth. IRSNB 785, 73.1 mm SL.

sixth are below the dorsal fin, the fifth including the midlateral spot and directed obliquely backwards towards the abdomen slightly in advance of the anal fin origin; the seventh runs across the posterior part of the nape and through the bases of the first two dorsal spines; the sixth and seventh bars are often split into two each. In large specimens (ca. 90 mm and larger) the pale interspaces between the second to sixth bars may appear faintly silvery. Nape dark above orbit.

The distinct dark markings consist of a vertical stripe on the cheek and a blotch on about the middle of the side. Specimens over 70 mm SL also have a faint narrow brownish (von Martius specimens) or icy blue (remainder) line bordering the infraorbitals and about half of the lachrymal inferiorly. Suborbital stripe brown or dark grey, of about pupil width, running from the lower margin of the orbit to the preopercle just above the angle. Midlateral spot dark brown to black, smaller than orbit, rounded or slightly ovate and then feebly backwards inclined (like the vertical bar in which it is contained). It covers E3 scales 12-13 or 12-14, sometimes 13-14 or 13-15, E2 and usually upper part of E1 scales below, often also adjacent part of E4 scales above.

Dorsal fin smoky, lappet tips narrowly darker. Specimens up to ca. 90 mm SL with indistinct hyaline spots on the posterior soft dorsal fin membranes, up to four between two rays; larger specimens mostly with immaculate dorsal fin. Anal fin greyish, the lower margin dusky or greyish; in well preserved large specimens with three oblique light stripes along most of its length and a few light spots posteriorly. Caudal fin with hyaline spots on middle and dorsal lobe interradial membranes (up to about six between two rays), ventral lobe dusky; hind margin, especially ventrally, often indistinctly dark-seamed. Pelvic fin hyaline inwardly, shadowing to greyish toward margin, but first ray outer margin and filament white.

Live colours: Stawikowski (1989, fig. 10) has a colour photo of a fresh caught adult specimen from Altamira. It is yellowish on anterior sides, chest and gill cover. The brown or blue stripe evident on the lachrymal and infraorbitals in preserved specimens is bright blue; also a spot on the lachrymal close to the eye, the upper lip and several spots on the preopercle, opercle and subopercle are blue. Blue stripes run along pelvic fin rays and across anal fin rays. The silvery spots on the midlateral blotch appear bluish. Specimens photographed in aquarium environment (Stawikowski, 1990a, b) appear similar.

Distribution

Collecting localities (Fig. 4) are in the upper (Cachoeira von Martius) and lower Rio Xingu (Altamira, Cachoeira do Espelho, Belo Monte) and the mouth of the Rio Curuá (cf. Snethlage, 1912, pp. 63-65). The Altamira specimens were collected in rocky shore areas with clear water (Stawikowski, 1989). The only other *Geophagus* species in the Xingu is *G. altifrons* Heckel which is sympatric with *G. argyrostictus* at Altamira (NRM 13733), Belo Monte (MZUSP 32921) and Cachoeira do Espelho (MZUSP 36876), and also has been collected at the mouth of Rio Culuene (MZUSP 32922) and in Rio Fresco at Gorotire (MZUSP 36000). *Geophagus altifrons* has a much wider geographic distribution in the central and eastern Amazon basin.

Breeding behaviour

Field and aquarium observations by Stawikowski (1990b) show that *G. argyrostictus* is a biparental substrate brooder.

Etymology

Named with reference to the silvery dots on the anterior sides; from the Greek *argyros*, silver, and *stiktos*, spotted; the specific name should be regarded as a declinable adjective.

DISCUSSION

In a revision of the genus *Geophagus*, Gosse (1976) distinguished ten valid species. Later papers (Kullander, 1986; Kullander and Ferreira, 1988; Kullander and Nijssen, 1989) distinguished four genera among *Geophagus* sensu Gosse, revalidated all names in *Geophagus* s. str. and added two new species. *Geophagus* s. str. is diagnosed above all by caudal ribs continuing the pleural rib series and long caudal prolongations of the swimbladder.

Most authors after Heckel (1840), including Gosse (1976), have referred nearly all material of true *Geophagus* to the species *Geophagus surinamensis*. Kullander and Nijssen (1989) found that species to be restricted to Surinam and French Guiana, and indicated that *G. surinamensis* auct. from the Amazon and Orinoco basins belongs to other species, many of which have not been formally described.

Geophagus argyrostictus is the second *Geophagus* species described that features a dark stripe from the eye to the preopercle in adults. The other species is *G. harreri* Gosse (Kullander and Nijssen, 1989). A suborbital stripe is present in most geophagine cichlids at least in juveniles, and also in juveniles of some *Geophagus* species that do not feature it as adults (unpubl.). Two more, undescribed, species of *Geophagus* are known, however, that feature a suborbital stripe much more prominent even than in *G. argyrostictus*. They were figured by Werner (1990) and both are being formally described elsewhere. Whereas this

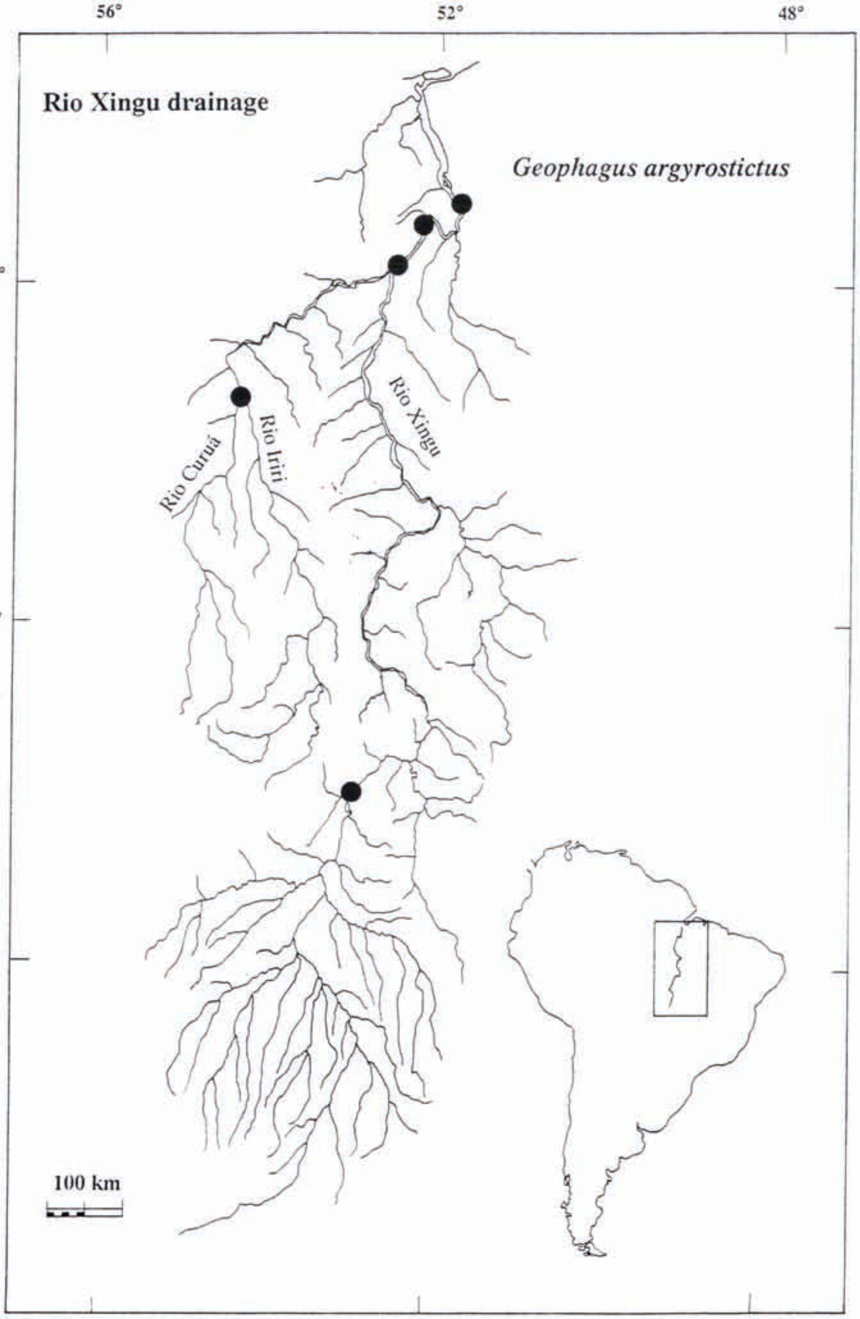

Fig. 4. - *Geophagus argyrostictus*. Geographical distribution. Localities from north to south: Belo Monte, Altamira, Cachoeira do Espelho, Rio Curuá, Cachoeira von Martius.

dark stripe is useful for identification, its significance as a relationship indicator is doubful as it is a plesiomorphic trait within the geophagine group. *Geophagus harreri*, which is restricted to the Marowijne River drainage in Surinam and French Guiana, is a very distinctive species in the genus, readily distinguished from *G. argyrostictus*, e.g., by having a ventrally pointed vertical bar across the side, a dark spot below the end of the dorsal fin base, and low dorsal fin count (modally D. XVI.12) (Kullander and Nijssen, 1989).

Silvery reflecting dots on flank scales are a unique character of *G. argyrostictus* among *Geophagus* species. Notable is also the absence of regular stripes of light spots in the dorsal fin which are found in several *Geophagus* species. For the rest, the colour pattern of *G. argyrostictus* does not deviate from the basic *Geophagus* pattern. Neither shape features or meristics offer unique distinguishing characters.

The substrate brooding behaviour of *G. argyrostictus* (Stawikowski, 1990b) contrasts with the mouth brooding in all other *Geophagus* species for which brooding behaviour is recorded (cf. Stawikowski and Werner, 1988). However, reproductive behaviour has been studied only in a few *Geophagus* species, that of species such as *G. harreri* and the Venezuelan cheek-stripe species is still unknown.

The geophagine genus *Gymnogeophagus* Miranda Ribeiro also includes both mouth brooders and substrate brooders (Stawikowski and Werner, 1988). It is possible that also *Satanoperca* Günther includes both categories (Kullander and Ferreira, 1988). One species of *Aequidens* Eigenmann & Bray, *A. diadema* Heckel, is reported as a mouth brooder in contrast to the other, substrate brooding, species in the genus (Peters and Berns, 1982; Stawikowski and Werner, 1988). This variation in brooding behaviour within cichlid genera is notable since in other cichlid genera as far as known all species are exclusively either mouth brooders or substrate brooders, and mouth brooding has been repeatedly used as a generic character among cichlids (e.g. Trewavas, 1983). *Geophagus* includes both species that start oral incubation immediately upon ovoposition (ovophilous mouth brooders; Peters and Berns, 1982) and species that start oral incubation when larvae appear (larvophilous mouth brooders; Peters and Berns, 1982) (Stawikowski and Werner, 1988). Given the behavioural evolution sequence from substrate brooding through larvophily to ovophily as envisaged by Peters and Berns (1982) in a more general context, it would seem that *G. argyrostictus* is relatively plesiomorphic in regard to brooding behaviour among *Geophagus* species and since information on breeding behaviour in *Geophagus* species is still very sketchy, does not suggest consequences for generic classification. In homogeneous taxa of mouth brooders, among tilapiine and haplochromine cichlids, mouth brooding can also be characterized by correlated behavioural and morphological autapomorphies, motivating recognition of separate genera or tribes (cf. e.g. table 1 in Trewavas, 1983). This is hardly the case in *Geophagus* which instead attracts interest for apparently preserving a behavioural evolutionary sequence without much morphological divergence.

The Cachoeira von Martius material of *G. argyrostictus* differs from that of the lower Xingu area in being slightly slenderer and averaging shorter pectoral and pelvic fins (Table I); it also features distinct silvery reflecting spots between the head and the midlateral blotch whereas in lower Xingu material the silvery spots are concentrated to the midlateral blotch area (Figs 1, 2). Upper Xingu material averages fewer teeth (9-24/12-24 vs. 19-30/19-26 in upper/lower jaw outer hemiseries), one less pectoral fin ray, one less external ceratobranchial 1 gill raker and one more abdominal vertebra than lower Xingu material (Table II).

The two geographic areas from which *Geophagus argyrostictus* is known, are separated by several rapids. Gene flow between them is most likely reduced, particularly as it seems that the species is restricted to sections with running water. With only one sample from Cachoeira von Martius and no collections from the 800 km stretch down to Altamira, it is impossible to decide whether variation is

Table II. - Geographical variation in count frequency in *Geophagus argyrostictus*. Upper Xingu material from Cachoeira von Martius; lower Xingu material from Altamira, Belo Monte and Iriri-Curuá.

	Gill rakers					Pectoral fin rays			Vertebrae			
	9	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*14+17*	*14+18*	*14+19*	*15+18*
Lower Xingu			2	19	9		7	25	1	4	1	
Upper Xingu	1	6	37			2	13			1	1	4

geographically continuous or discrete, or how representative the single sample from Cachoeira von Martius is. Other rapids cichlids, *Teleocichla gephyrogramma* Kullander and *T. monogramma* Kullander, have been collected both in Cachoeira von Martius and at Altamira, and suggest wide ranging species distributions along the Xingu (Kullander, 1988 and unpubl.)

Acknowledgements. - I thank Jean-Pierre Gosse and Louis Walschaerts (IRSNB), Michael Goulding (formerly Museu Goeldi), Harald Ahnelt (NMW), Heraldo Britski (MZUSP) and Rainer Stawikowski for access to study material, and my wife Anita Hogeborn-Kullander for the photographs, Figs 1-2. This paper was written with support from the Swedish Natural Science Research Council, grant no. B-BU 4568. This is contribution no. 5 from the project Diversity of Tropical Freshwater Fishes of the Department of Vertebrate Zoology, Swedish Museum of Natural History.

REFERENCES

GOSSE J.-P., 1976. - Révision du genre *Geophagus*. *Mém. Acad. r. Sci. Outre-mer. Cl. Sci. nat. méd. (N.S.)*, 19(3): 1-172.

HECKEL J., 1840. - Johann Natterer's neue Flussfische Brasilien's nach den Beobachtungen und Mittheilungen des Entdeckers beschrieben. (Erste Abtheilung, die Labroiden.) *Annln Wien. Mus. Natges.*, 2: 327-470.

KULLANDER S.O., 1979. - Species of *Apistogramma* from the Orinoco drainage basin, South America, with descriptions of four new species. *Zool. Scr.*, 8: 69-79.

KULLANDER S.O., 1980. - A redescription of the South American cichlid fish *Papiliochromis ramirezi* (Myers & Harry, 1948). *Stud. neotrop. Fauna Envir.*, 15: 91-108.

KULLANDER S.O., 1986. Cichlid fishes of the Amazon River drainage of Peru. Stockholm, 431 pp.

KULLANDER S.O., 1988. - *Teleocichla*, a new genus of South American rheophilic cichlid fishes with six new species. *Copeia*, 1988: 196-230.

KULLANDER S.O., 1990. - *Mazarunia mazarunii*, a new genus and species from Guyana, South America. *Ichthyol. Explor. Freshwaters*, 1: 3-14.

KULLANDER S.O. & E.J.G. FERREIRA, 1988. - A new *Satanoperca* species from the Amazon river basin in Brazil. *Cybium*, 12: 343-355.

KULLANDER S.O. & H. NIJSSEN, 1989. - The cichlids of Surinam. E.J. Brill, Leiden and other cities, xxxiii + 256 pp.

PETERS H.M. & S. BERNS, 1982. - Die Maulbrutpflege der Cichliden. Untersuchungen zur Evolution eines Verhaltensmusters. *Z. zool. Syst. Evolforsch.*, 20: 18-52.

SNETHLAGE E., 1912. - A travessia entre o Xingu e o Tapajoz. *Bolm Mus. Goeldi (Mus. para.) Hist. nat. Ethnograph.*, 7: 49-99.

STAWIKOWSKI R., 1989. - Ein Erdfresser mit verschiedenen Gesichten *Geophagus altifrons*. *Aquar. Terrar. Z.*, 42: 476-480.

STAWIKOWSKI R., 1990a. - Neu importiert: Wieder Fische vom Xingú. *Aquar. Terrar. Z.*, 43: 7-8.

STAWIKOWSKI R., 1990b. - Offenbrütende *Geophagus*! *Aquar. Terrar. Z.*, 43: 519.

STAWIKOWSKI R. & U. WERNER, 1988. - Die Buntbarsche der Neuen Welt. Südamerika. Essen, 288 pp.

TREWAVAS E., 1983. - Tilapiine fishes of the genera *Sarotherodon, Oreochromis* and *Danakilia*. London, 583pp.

WERNER U., 1990. - Wangenstrich-Erdfresser: Es gibt zwei Arten. *Aquar. Terrar. Z.*, 43: 453-454.

Reçu le 09.10.1990.
Accepté pour publication le 22.03.1991.